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Patentanmeldung Nr. Patent application No. Demande de brevet n°

03300281.7

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

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Koninklijke Philips Electronics N.V.
Groenewoudseweg 1
5621 BA Eindhoven
PAYS-BAS

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

A data receiver having means for minimizing interference and method used in such a receiver

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PT RO SE SI SK TR LI

A data receiver having means for minimizing interference and method used in such a receiver.

FIELD OF THE INVENTION.

The present invention relates to a data receiver having means for minimizing interference.

BACKGROUND OF THE INVENTION.

This kind of data receiver is used in mobile phones, which comply with the UMTS standard. For the data transmission, this standard proposes to use spreading codes having orthogonality properties.

An important problem that such mobile phones face is to eliminate the effect of propagation paths of the data. A known solution for eliminating this interference, is to use the CPICH channel, which transmits 256 "1" transformed in "1+j" after modulation. So, at the receiver side in the mobile, the channel can be estimated in an easy way. The following references can be consulted as prior art considerations.

-3GPP TSG R1-00-1371

"CPICH interference cancellation as a means for increasing DL capacity"

-3GPP TSGR R4-01-0238

"CPICH interference cancellation as a mean for increasing DL capacity"

-3GPP TSGR R1-01-0030

"Further results on CPICH interference cancellation"

-3GPP TR 25.991 V2.0.0 (2001-03)-

SUMMARY OF THE INVENTION.

The invention proposes to improve the cancelling of a certain amount of interference with respect of the above cited prior art. According to the invention, a data receiver is defined in the following way:

-A data receiver for receiving user data and reference data coming from a transmitter via at least a channel, comprising means for unscrambling and means for despreading received data, means for analyzing the characteristic of the channel, means for evaluating the contribution of interferences of data provided by the channel and a

substractor means intended for cancelling the contribution of interference in the user data, said substractor means being placed before said unscrambling means.

These and other aspects of the invention are apparent from and will be elucidated, by way of non-limitative example, with reference to the embodiment(s) described hereinafter

BRIEF DESCRIPTION OF THE DRAWINGS.

The present invention will now be described in more detail, by way of example, with reference to the accompanying drawings, wherein:

-Fig.1 shows a system in which the invention is applied.

-Fig. 2 shows a transmitter from which CPICH is transmitted

-Fig.3 shows a data receiver according to the invention

-Fig.4 shows a part of the receiver shown in Fig.3

-Fig.5 shows a second part of the receiver shown in Fig.3

DETAILED DESCRIPTION OF THE INVENTION.

Fig.1 shows a system in which the invention is applied. The system is a CDMA system and concerns cellular radio mobile system. The reference 1 shows a base station comprising a transmitter 2 having a high frequency part 3 and the reference 5 a mobile station. The liaison from the basse station and the mobile is determined by a given scrambling code. The arrows P1, P2, P3.... indicate many paths, providing various delays $\tau 1$, $\tau 2$, $\tau 3$., by which the waves are propagated from an antenna 6 connected to the output of the high frequency part 3 to an antenna 8 that the mobile 5 comprises. The mobile station can be disturbed by liaisons having another scrambling code.

Fig.2 shows, in a schematic way, the transmitter 2. It comprises the high frequency part 3 the output of which is connected to the antenna 6 and an input connected to a data multiplexer 12, via a transmitting filter 13. This multiplexer 12 receives, notably, data from the user, which is indicated by an user box 15, and data coming from the CPICH. The CPICH data are constituted by a "1" sequence. Before transmitting, theses data are scrambled by a scrambling sequence Scr thanks a scrambling device 17; a spreading code Sp is also applied, as it is known.

Fig. 3 shows in a schematic way a mobile station 5. As usual, it comprises a screen 25, a speaker 26, a microphone 27 and a keyboard 28. A general electronic part 29 manages all the tasks not specially concerned by the invention. In this Fig. a receiver part 30 is more detailed. This part 30 comprises a high frequency head 31 from which data are provided, after a receiving filter 32 at a high rate elaborated by an over-sampling device 34. The high frequency head 31 provides also data to a channel estimator 35 and to a delay estimator 38, which determines the delays $\tau 1$, $\tau 2$, $\tau 3$.,of the cited paths P1, P2, P3..... Scrambling codes are delivered by a scrambling code generator 39.and spreading codes by a spreading code generator 40.. All the codes provided by the elements 35, 38 and 39 can be used by a Rake type receiver 42. The output of this receiver 42. is connected to the input of the electronic part 29. The receiver 42 comprises a plurality of fingers RF1,..RFj,..RFk,..and RFJ as it is usual for this kind of receiver. A combiner device 45 combines all the information coming from the finger for providing symbols.

The Fig.4 shows the structure of the Rake finger RFj cooperating with the other parts of the receiver. The finger RFj comprises a plurality of interference estimators alloted to each path respectively. IEP1Fj is the interference estimator of the path 1 on finger 1..... IEPkFj. is the interference estimator of the path k on finger j and so on. The output of these estimators are added by the adding device 60. The estimations of the interferences are substracted from the data signal provided by the head 31 thanks a substractor 62. The data signal data is delayed by the delay device 61 which delays the data by an amount which is in relation with the delay of the concerned path. After this operation, an unscrambling operation is performed by the multiplier 64 which provides data from the scrambling code coming from generator 39. As the data are in complex form, a conjugate device 66 evaluates the conjugate of the scrambling code. This scrambling code is the scrambling code alloted to the liaison. Finally the data are despreading by the multiplier 68 taking in account the code provided by the generator 40.

In the Fig.4, the interference estimator IEPkFj is more detailed. It comprises a plurality of correlators COR1...CORJ-1 the number of which is dependent of the number of paths. The output signals of these correlators are added by the adder 70 and from here to the adder 60.

The Fig.5 shows the structure of the correlator CORj. This correlator receives the scrambling codes Scrj of the other liaisons which contribute to the interferences to be cancelled. Note that there are J-1 such correlators fo each finger, as it is possible to

eliminate the interference of all j paths with j≠k with k the finger which is considered. For that, the estimation $\hat{h}j$ of the liaison and the delay τj of the other paths are considered. All these parameters are not the parameters of the main liaison but those of the parasitic ones. A multiplier 80 performs an operation concerning $\hat{h}$ and the value of the CPICH ie "1+j" in complex form.. 2 N multipliers M(-N) to M(+N) performs an operation with the scrambling code of the parasitic liaison delayed in accordance with the delay τj s of these liaisons. The output signals of these multiplier are applied to the operators ρ(-N) to ρ(+N). N is in relation with the number of interference coefficients ρ taken in consideration, each coefficient being generated by the cross-correlation of the transmitting and the receiving filter, as in the formula below (where by example value N=8, but this can vary as a parameter). An adder 85 sums all the signals at the output of these multipliers before being applied to the adder 70.

The working of the channel estimator is facilitated by the determined "1" sequence coming from the CPICH and transformed in "1+j" considered in complex form. By this way, the coefficients $\hat{h}$ of the pulse response of the channel are defined with an easy way. From these received data, the delay τ1, τ2, τ3 provided by the various paths P1, P2, P3,... are also estimated in the delay estimator 38.

Finally, the interference estimator performs the following formula:

$$r(n)=\sum_{k=\Delta_{j,i}-8}^{\Delta_{j,i}+8}\rho(k*Tc-(\tau_j-\tau_i))*\hat{h}_j*S_{c,n+k*Tc}*S_{p,n+k*tc}*(1+j)$$

In this formula,

ρ is the cross-correlation between the transmit and receive filter,

$\hat{h}_j$ is channel coefficients of the path j,

$S_{c,n}$ is the scrambling sequence,

$S_{p,n}$ is the spreading sequence of the pilot channel,

1+j is the CPICH symbol,

Tc is the duration of a chip (time slot obtained after scrambling).

$\tau_j-\tau_i$ is the delay between the path i and the path j

with :

$$\tau_1-\tau_0=\Delta_{1,0}.T_c+\Omega_{1,0}.\frac{T_c}{OS}\qquad |\Omega_{1,0}|<OS$$

OS is an integer that represents an over-sampling factor. $\Delta_{1,0}$ is an integer which measures the delay in T_c unit and $\Omega_{1,0}$ the number of over-sampling periods.

It must be understood that the invention covers the case for which the realization of all the disclosed embodiments is made by processor and a convenient software.

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CLAIMS

1) A data receiver for receiving user data and reference data coming from a transmitter via at least a channel, comprising means for unscrambling and means for despreading received data, means for analyzing the characteristic of the channel, means for evaluating the contribution of interferences of data provided by the channel and a substractor means intented for cancelling the contribution of interference in the user data, said substractor means being placed before said unscrambling means.

2) A data receiver as claimed in claim 1, characterized in that the data are in compliance with the UMTS standard.

3) A data receiver as claimed in claim 2, characterized in that the reference data are provided by the CPICH channel.

4) Method for receiving user data and reference data coming trom a transmitter via at least a channel which provides interference in user data, comprising the following steps :

- analysing the characteristic of the channel by using the reference data,
- determing an evaluation of the interferences of data provided by the channel
- substracting the evaluation of interference from the received user data and
- unscrambling the user data.

A data receiver having means for minimizing interference and method used in such a receiver.

ABSTRACT

The present invention relates to a data receiver (5) for receiving user data and reference data (CPICH) coming from a transmitter 5 via at least a channel. This receiver comprises means for unscrambling (and means for despreading received data, means for analyzing the characteristic of the channel, means for evaluating the contribution of interferences of data provided by the channel and a substractor means intended for cacelling the contribution of interference in the user data, said substractor means being placed before said unscrambling means.

Reference: Fig.2

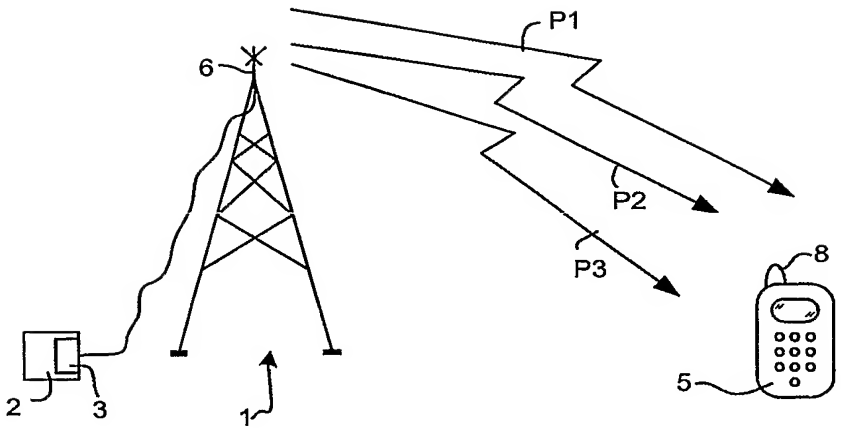


FIG.1

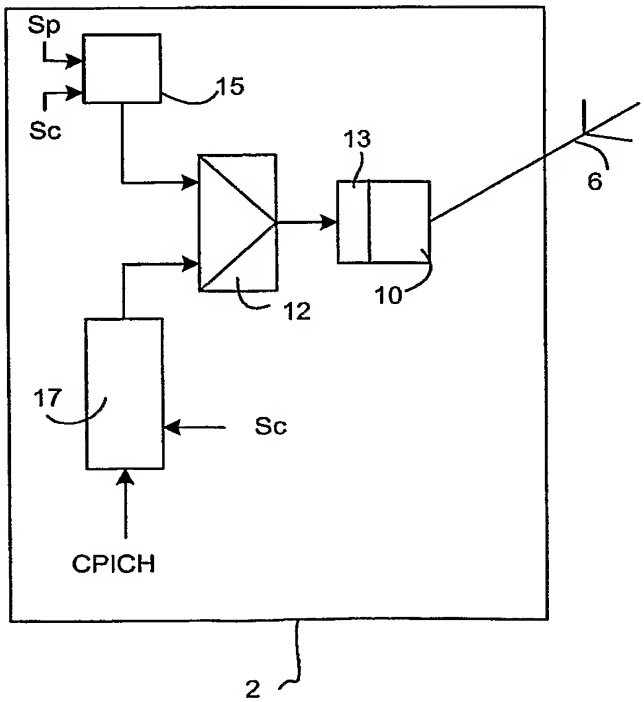
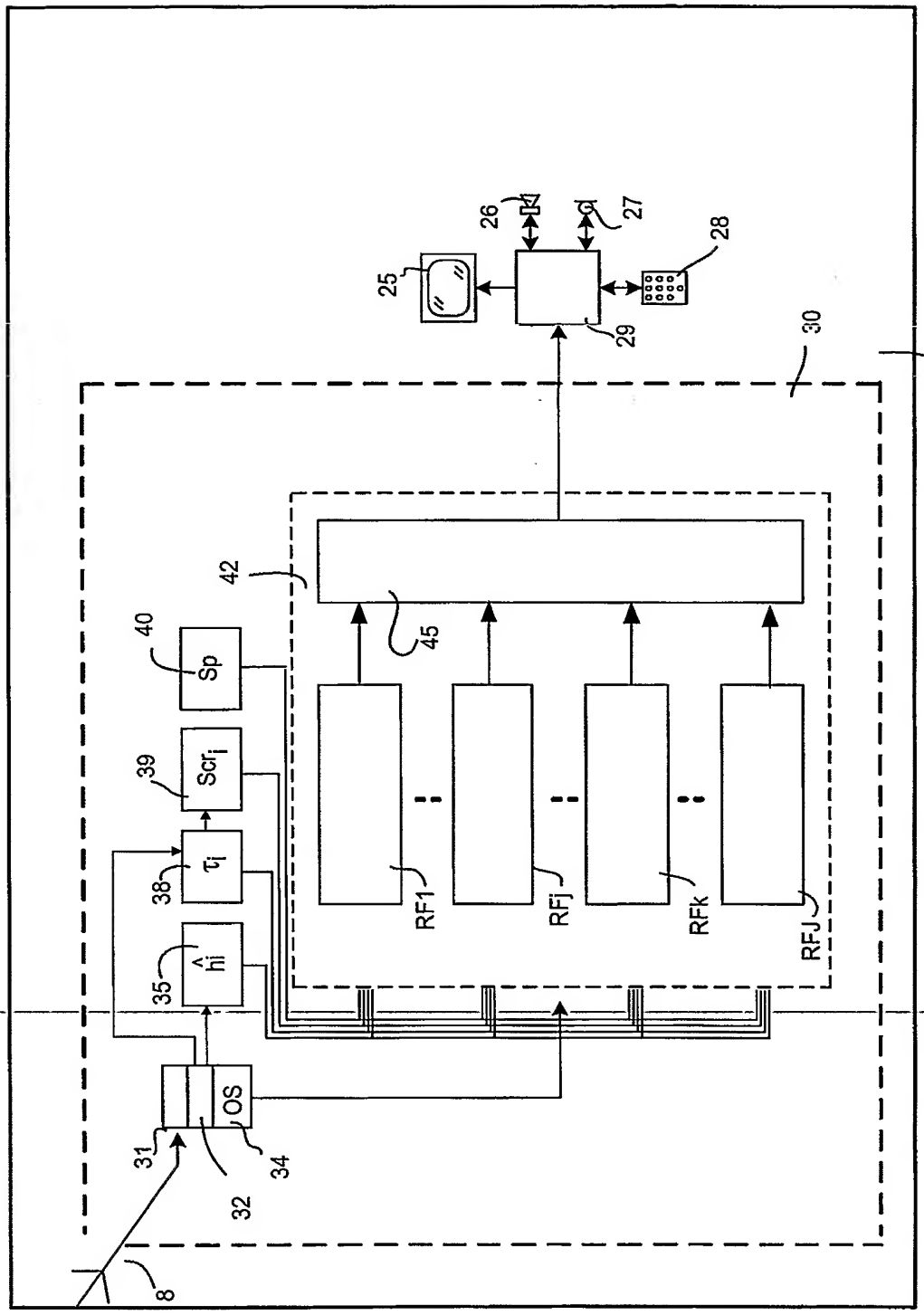


FIG.2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27
28
25
29
30
5
42
45
40
Sp
39
Scr_i
38
τ_i
35
ĥ_i
OS
31
32
34
8
RF1
RFj
RFk
RFJ

FIG.3

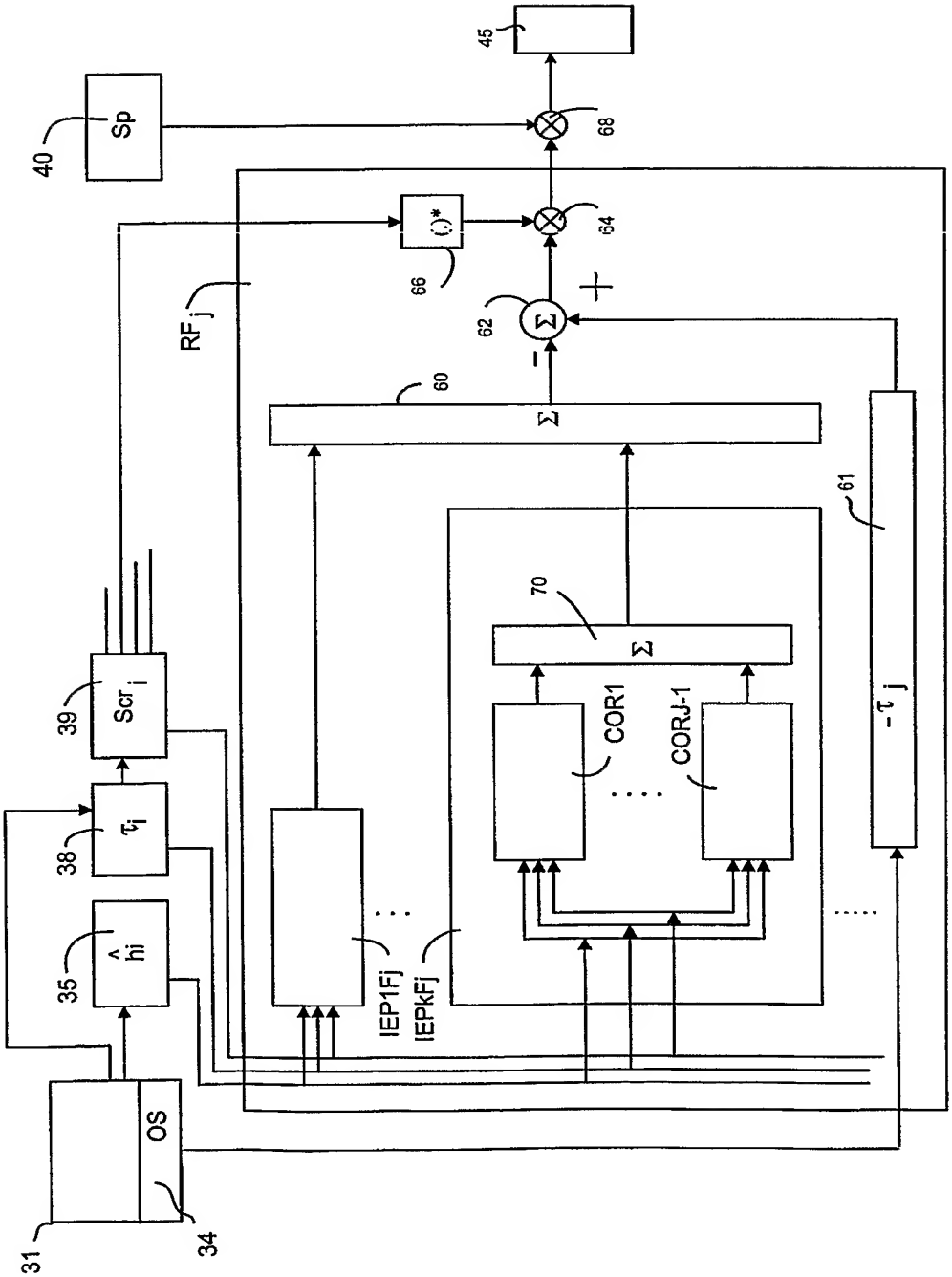
45
Sp
40
68
64
(.)*
66
RF j
62
Σ
60
Σ
61
70
Σ
Scr i
39
τi
38
35
hi
OS
31
34
IEP1Fj
IEPkFj
COR1
CORJ-1
-τ j

FIG.4

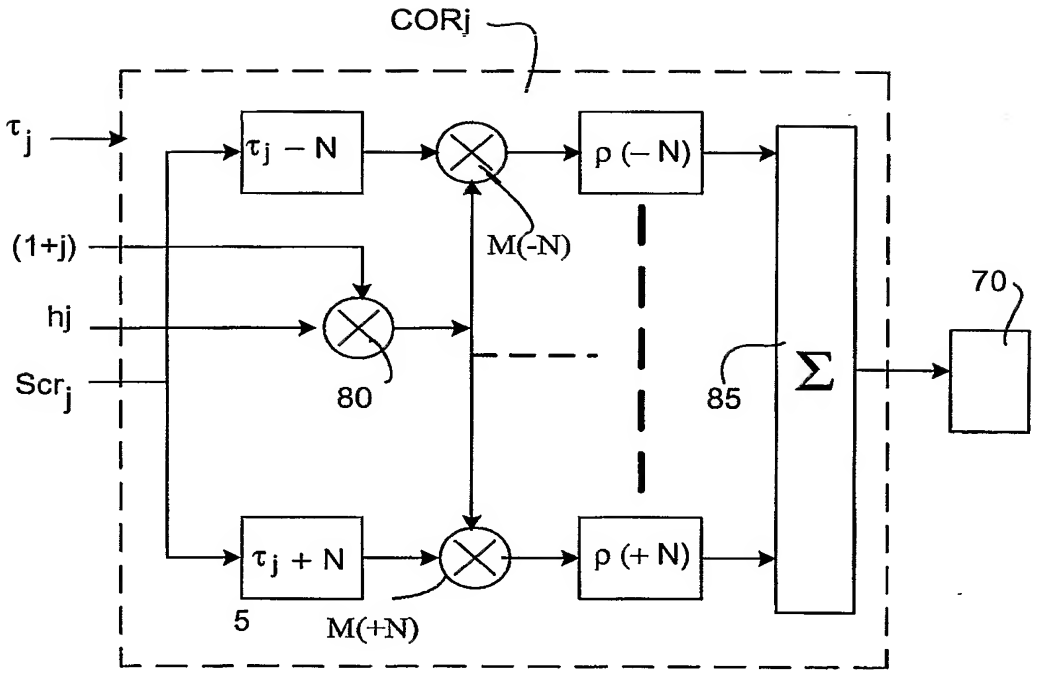

FIG.5